Case Study of a Large IXP

Overview of what Large IXP Operations look like

Agenda

- The History and Background

- Governance Structure

- Growth Strategy

  - Technology Evolution

  - Services

- Communication and Outreach

  - Website and online information

  - Meetings and Conferences

  - Partners and Collaborations

Introduction

- This presentation will evaluate some of the 7 large IXPs in the world by traffic volume and membership namely;
    - London Internet Exchange (LINX),
    - Amsterdam Internet Exchange (AMS-IX),
    - Frankfurt Internet Exchange (DEC-IX),
    - Sweden IX operator (Netnod),
    - Hong Kong Internet Exchange (HKIX),
    - Singapore Internet Exchange (SGIX)
    - Korea Internet Neutral Exchange (KINX)
- The above IXPs have members/peers from beyond their geographical region
- We shall review the IXPs inception and evolution path into large IXPs
- The objective is to highlight the similarities and common practices of large IXPs

HUMBLE BEGININGS

History and Background

- **Stockholm:** In 1992 Swedish University Computer Network (SUNET) developed a solution allowing it to connect to 2 operators at a neutral exchange called D-GIX and became the first Swedish IXP located at KTH University.

- **London:** LINX was establish in Nov 1994 using donated equipment; no legal contract to connect 5 UK ISPs to avoid paying Trans-Atlantic bandwidth costs for local traffic. The switch was located at Telehouse a virtually empty data center at the time.

Historical Background

- **AMSTERDAM:** In the Science Park in Amsterdam a layer-2 shared infrastructure was formed between (academic) organisations to exchange traffic. In February 1994 it was internationalised to exchange traffic with CERN in Switzerland and other Internet Service Providers (ISPs) were allowed to connect. The name AMS-IX was first used.

- **FRANKFURT:** DECIX was established in 1995 and was located in a former post office building

History and Background

- **Hong Kong:** HKIX was initiated as a project by the Information Technology Services Center (ITSC) of the Chinese University of Hong Kong (CUHK) in 1995

- **Seoul:** Korea Internet Exchange (KIX) was established in Feb, 1995 by the National computerization Agency to connect the Education network and the Research Network. 11 ISPs were connected later that year. Later in 1996 ISP were moved to the commercial IXP located at Korea Telecom. In 1999, Korea Internet Exchange Association comprising of many ISPs setup a neutral IX called Korea Internet Neutral Exchange (KINX)

Summary of background

- The large IXPs were established through initiatives involving the academic and research networks to interconnect with local ISPs and providers

- The initial setup consisted of;
  - informal agreements,
  - donated equipment,
  - Donated space and,
  - volunteers to run the operations

GOVERNANCE AND FORMAL STRUCTURES

Governance Structure

- **Stockholm:** Following discussion at the Swedish Operators Forum (SOF), an new entity to run the IXP was formed. The basic concept was that no single telecom operator would have undue influence over another. This organisation would work for the good of the Internet, not for commercial gain.

- **London:** The company was formed in 1995 limited by guarantee and a board of five non-executive directors was elected. It was agreed that LINX would be a non-profit organisation run for the benefit of members and governed by them collectively through regular member meetings, a practice which continues to this day.

Governance Structure

- **Amsterdam:** Twenty connected ISPs and carriers found the AMS-IX Association. The Association formed the AMS-IX limited company, AMS-IX B.V., and has since been holding all its shares. All assets were transferred to the company.

- **Hong Kong:** CUHK runs HKIX as a not-for-profit initiative and considers it as critical Internet infrastructure

Governance Structure

- **Frankfurt:** DE-CIX was initially established as a commercial IX hence the name **Deutscher Commercial Internet Exchange.** Despite being commercial their values, vision and mission are consistent with not-for-profit IX's
  - Integrity and honesty
  - Passion for customers, partners and technology
  - Commitment to serving the Internet community
  - Openness, transparency and accountability

Summary of Governance Structure

- Most of the large IXPs are not-for-profit organizations

- Some of the large IXPs are commercially operated but uphold some of the IX values

- In some instances, there has been transition of the IX assets and share from the original "association" entity to a more neutral/independent not-for-profit organisation.

THE GROWTH FACTOR ON TECHNOLOGY AND SERVICES

Growth Strategy

- All the large IXPs have developed strategies to evolve and attract ISPs outside of their geographical region

- This happened after the IXPs reached a certain level of growth and maturity

- The transition to more independent organizations and corporate structure also played a role in developing the growth strategy

Growth Strategy

- **Stockholm:** In 2000, a long discussion between several of SOF's partners took place about how to increase Netnod's operational responsibility for the Internet exchange points.
  - That year Netnod established exchange points in Malmö and Sundsvall.

- **London:** In 2001 LINX amended its corporate structure to make the post of chairman non-executive and appointed its first chief executive officer.
  - By 2004, LINX had considerably expanded its footprint, with four new points of presence (PoPs) - all in the Docklands area of London.

Growth Strategy

- **Amsterdam:** In 2002, the operations management of the exchange was integrated into the AMS-IX Company. A professional NOC was formed.
  - That year, AMS-IX extended the platform to two other sites in Amsterdam

- **Frankfurt:** In 2003 a second node was established in Frankfurt
  - In 2006 the first non-technical staff for customer service and business development were hired
  - DECIX evolved from a purely tech driven company and broadened its focus
  - Strategy to go East: Eastern Europe and Russia was formulated

- **Hong Kong:** A new redundant site was established in 2004

Technology Evolution

- From the year 2002 a number of technological advancements were made.

- The 1 Gigabit Ethernet services were in use at LINX by 2000.

- **London:** In 2002 LINX was the first exchange to introduce 10G Ethernet operation (over Copper)

- **Amsterdam:** In 2004, AMSIX platform was migrated from a ring to a double star topology. Trunked Gigabit and 10 Gigabit Ethernet services were launched (LACP).

Technology Evolution

- Online video streaming emerged online in 2005 bringing a new demand for increased bandwidth.

- By 2006 most of the large IXPs had 10GE ports available.

- The availability of 10GE and link aggregation options lead to an increase in port orders and equally on aggregate traffic exchanged at IXPs

- By 2005 the 5 minute aggregate at AMS-IX had reached 120Gbps

Technology Evolution

- Between 2009 and 2013 most of the large IXPs made significant technical significant upgrades and advancements to their IXP infrastructure including;
  - Introducing DWDM Technology
  - Migration to new vendors
  - Support for 100GE ports
  - MPLS/VPLS technology

- The first 100GE port for LINX went live in 2012 just before the London Olympics

From …..to …..

Legend (left diagram):
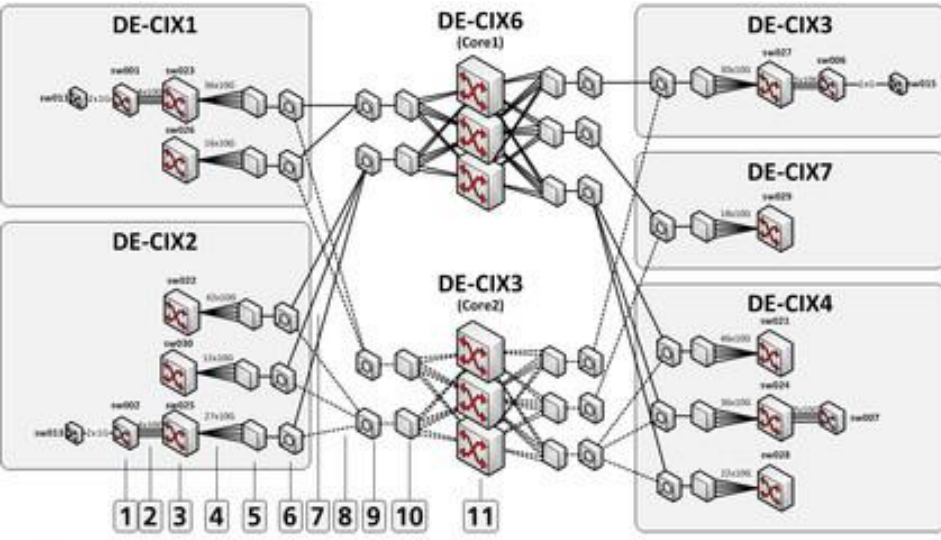
1. Force10 Terascale E1200
2. Multiple 10G-Connections
3. Force10 Exascale E1200i
4. Multiple 10G-Connections
5. DWDM MUX 32 Channel
6. Lynx LightLeader Master Unit
7. Dark Fiber Working Line
8. Dark Fiber Protection Line
9. Lynx LightLeader Slave Unit
10. DWDM MUX 32 Channel
11. 2xBrocade MLX32 and 1xForce10 Exascale 1200i per Core

Legend (right diagram):
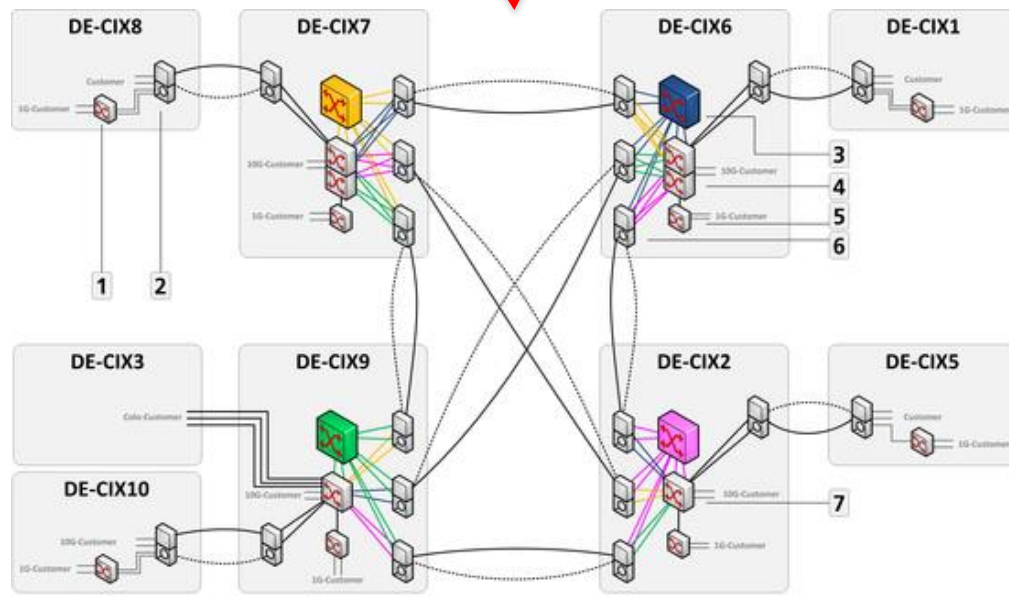
1. Alcatel-Lucent 7210 SAS-M
2. ADVA FSP3000R7 for Remote-Locations
3. Alcatel-Lucent 7950XRS20 Core-Node
4. Alcatel-Lucent 7950XRS40 Edge-Node
5. Alcatel-Lucent 7210 SAS-M
6. ADVA FSP3000R7 for Interconnect-Connections
7. Alcatel-Lucent 7950XRS20 Edge-Node

AMS-IX Platform Evolution
Version 1.0 - 1996 to Q3 2000
Version 1

Peak traffic 3 Gbit/s Dec 2000

Sep 1996 13 members

Dec 2000 108 members

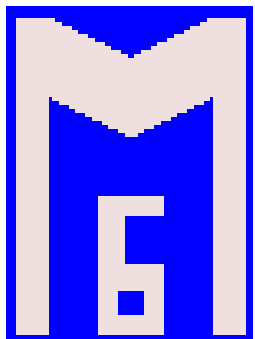**AMS-IX Topology Map**

NIKHEF location

SARA location

AS1200 router

hub
hub
hub
hub

100BaseTX — multi-mode fiber — 100BaseTX

Catalyst 5000

Catalyst 5000

1000BaseSX — multi-mode fiber — 1000BaseSX
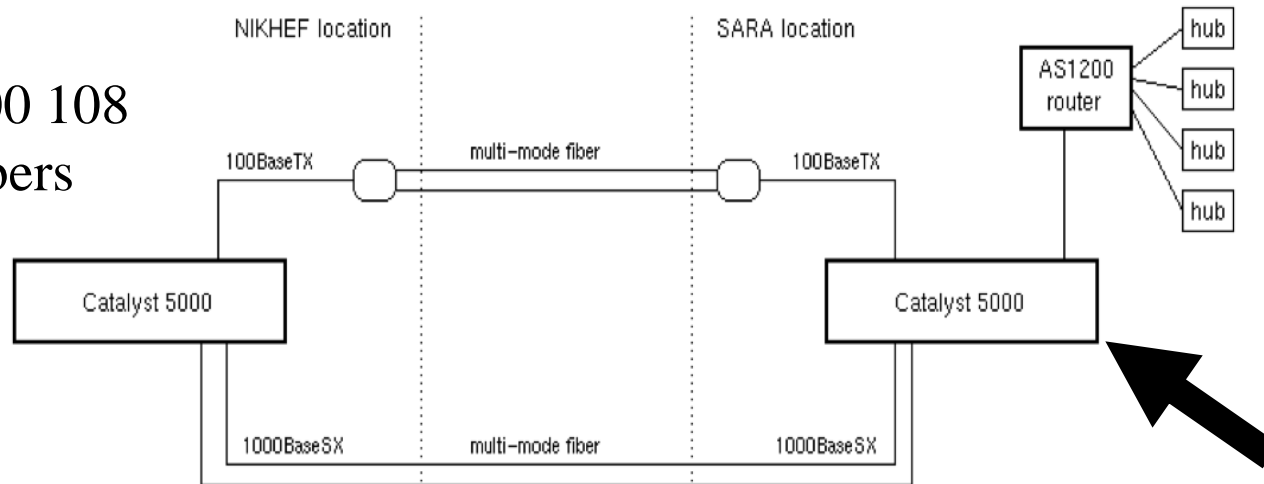
Connections on:
* 10BaseT HDX
* 100BaseTX FDX

Connections on:
* 10BaseT HDX
* 100BaseTX FDX

Catalyst 5000 replaced by Foundry BI 8000 Ironcore Q1 2000

Peak load ISL Q4 2000 500 Mbit/s

AMS-IX Platform Evolution
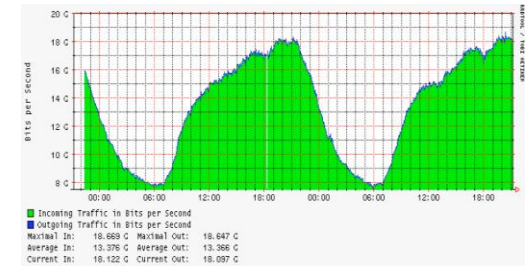## *Version 2.0 - Q1 2001 to Q4 2003*

(R)STP loop protection protocol

Backbone links upgraded from GE to 10GE End 2002

End 2003 Upgrade to BI-15000 JetCore
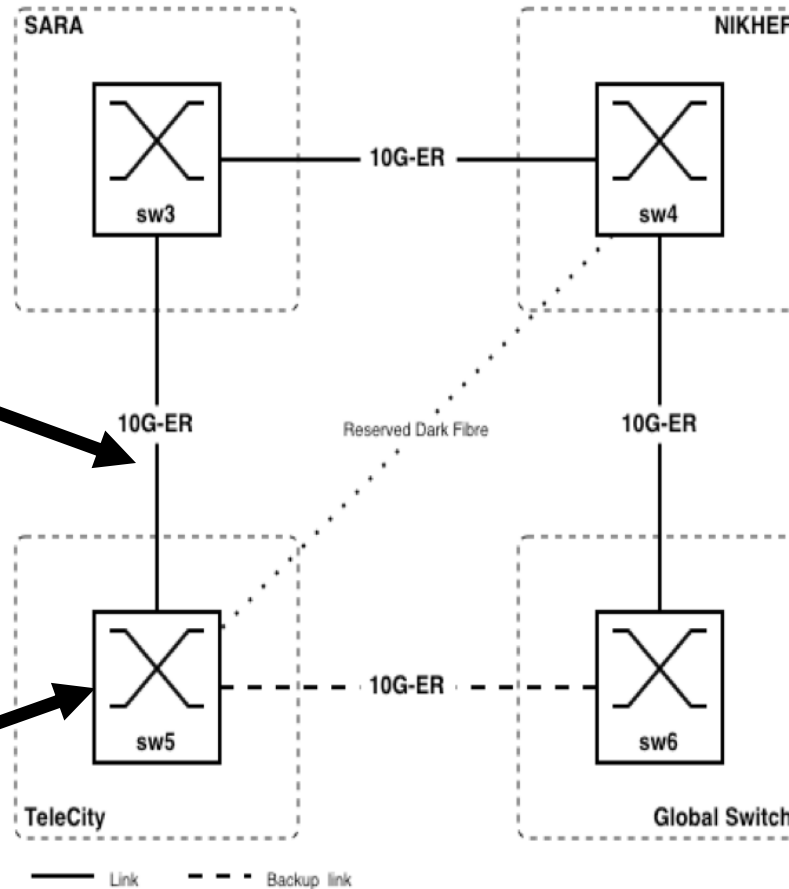
235 ports total
95 GE ports < FE ports

AMS-IX Platform Evolution
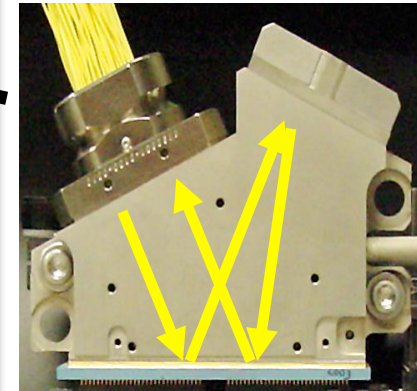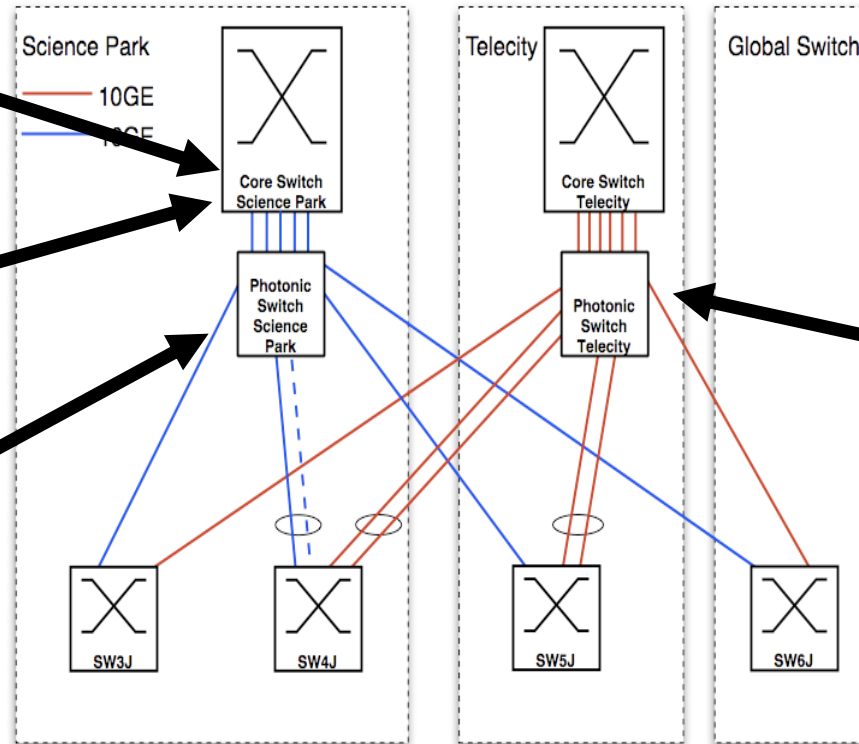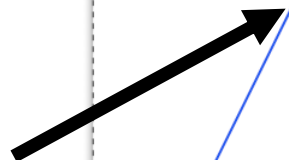## *Version 3 Q1 2004 - Q2 2009*

Double Star topology: VSRP

First Generation Core
BI-15000 JetCore

Second Generation Core
Foundry MG8

Glimmerglass
Photonic Cross Connects
Allowed for smooth
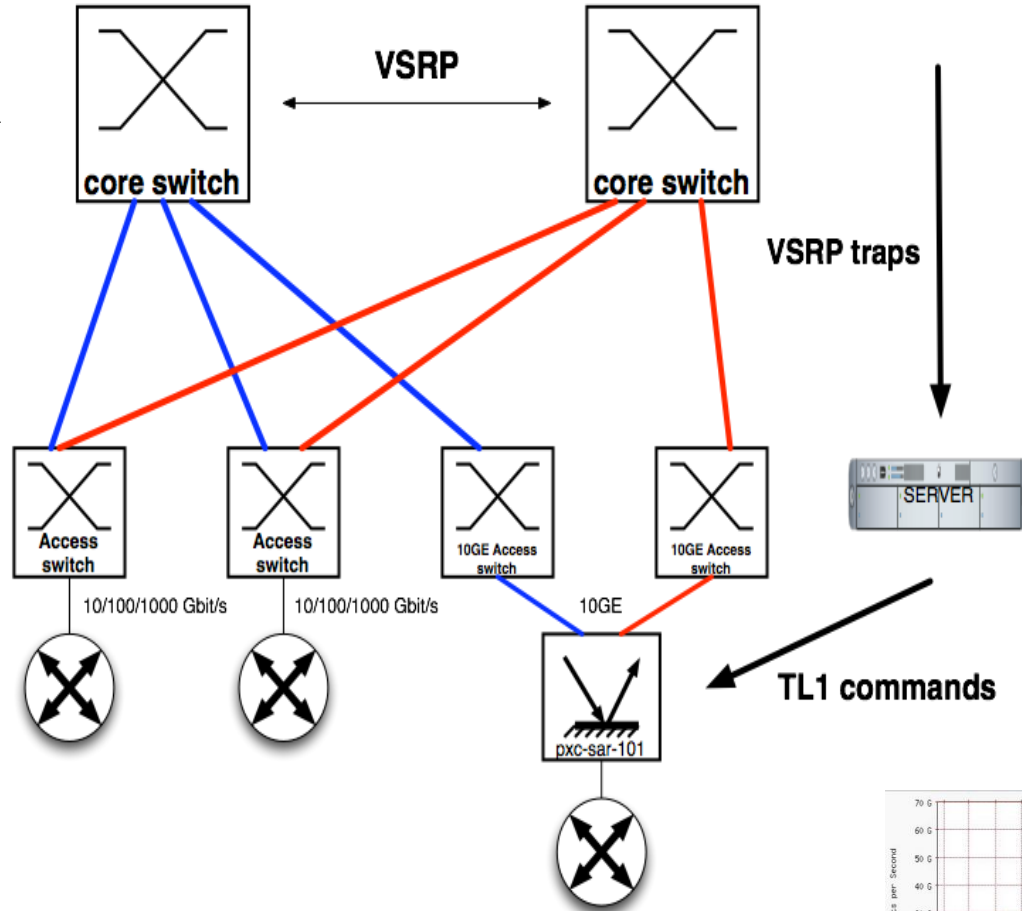migration of ring to
double
star topology

amsix
amsterdam internet exchange
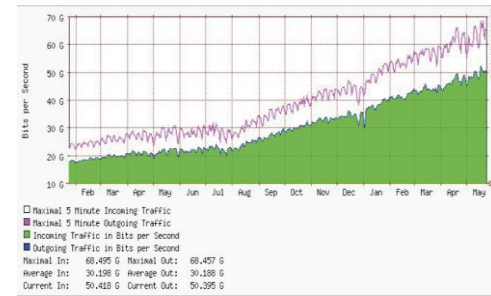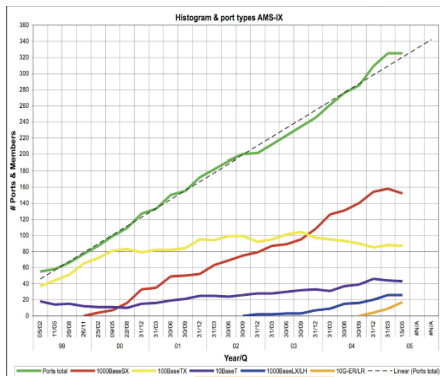
AMS-IX Platform Evolution
Version 3 Q1 2004 - Q2 2009

Dec 2003 introduction first customer GE aggregate

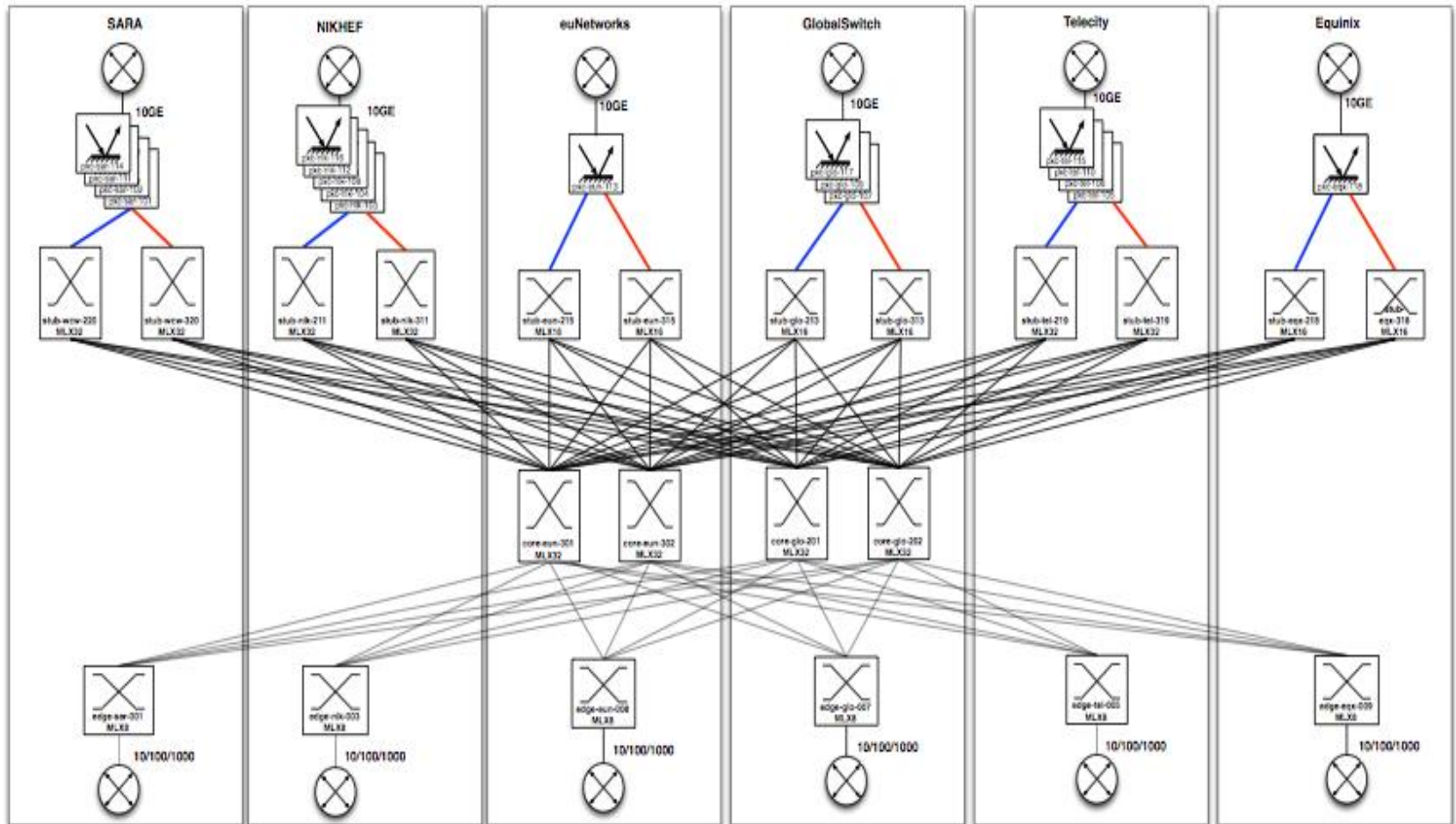Q4 2004 First 10GE customer ports directly on the core via PXC VSRP traps drive PXC failover

Ports Q2 2005

AMS-IX Platform Evolution
Version 4 Layer 1

Services

- The Large IXPs provide the following basic services;
    - Bilateral Layer 2 peering service
    - Route-Server Service
    - NTP Servers
    - DNS
    - Virtual LANs (VLANs)
    - Private Peering over VLANs or Private Interconnects
    - Link Aggregation Control Protocol (LACP) enables combining multiple switch ports into one link

- Additional Value added services introduced are;
    - Remote Peering
    - Reseller program
    - MPLS/VPLS
    - Mobile Peering

Growth, Technology and Services Summary

- The large IXPs growth strategy required significant investment in technology
- The Technological advancements enabled the introduction of new services and higher port speeds
- The new services have enabled new members to connect including remote members
- Internet growth drove the uptake of new higher port speeds.
- The large IXPs aggregate traffic ranges between 150GE – 3Tbps of traffic exchange and have between 200 - 600 Networks (ASNs).
- The large IXPs have automated their services and provided high level or redundancy to achieve 100% uptime

Communication & Outreach

- The large IXPs have enhanced their communication and visibility through the following
  - Website and online Information
  - Meetings and Conferences participation
  - Partners and Collaboration

Website and Online Information

- Most of the large IXPs will provide on their website the following information
  - Their Members, ASN, Peering Policy and Port Speed taken at the IXP
  - The number of port in use and different ports speeds
  - The ASNs available, Prefixes,
  - The Usage stats for daily, monthly, annually and upto 5 years
  - The IXP network topology
  - Peering locations and stats for each location
  - Pricing Information
  - Joining and policy information
- Most of them are visible on social media i.e Facebook, twitter, LinkedIN, etc
- Some large IXPs produce online magazines and reports
- The look and feel also changed for instance the logo of AMS-IX has gone through 3 changes

Clear Pricing Information

Prices as of July 1, 2013

| Port	Monthly fee in Euro (excluding SLA)	Monthly fee in Euro (including SLA)**
≤GE	NA - through reseller only	NA - through reseller only
GE	500	600
10GE	1000	1250
100GE 10x10-2km*	5000	5750
100GE LR4	5000	5750

* This is sometimes referred to as LR10-2km

Pricing table, effective from July 1st, 2013.

All prices are monthly recurring charges ("MRC")

Product	Speed/Gbps	MRC eco member	MRC non eco member
1GE Fractional 1000 Base-LX	0.2	200 €	350 €
1GE line rate 1000 Base-LX	1	500 €	750 €
10GE fractional 10000 Base-LR*	2.5	1200 €	1450 €
10GE line rate 10000 Base-LR*	10	1900 €	2250 €
100GE line rate 100000 Base-LR4	100	12500 €	16500 €

Multi-year Graphs
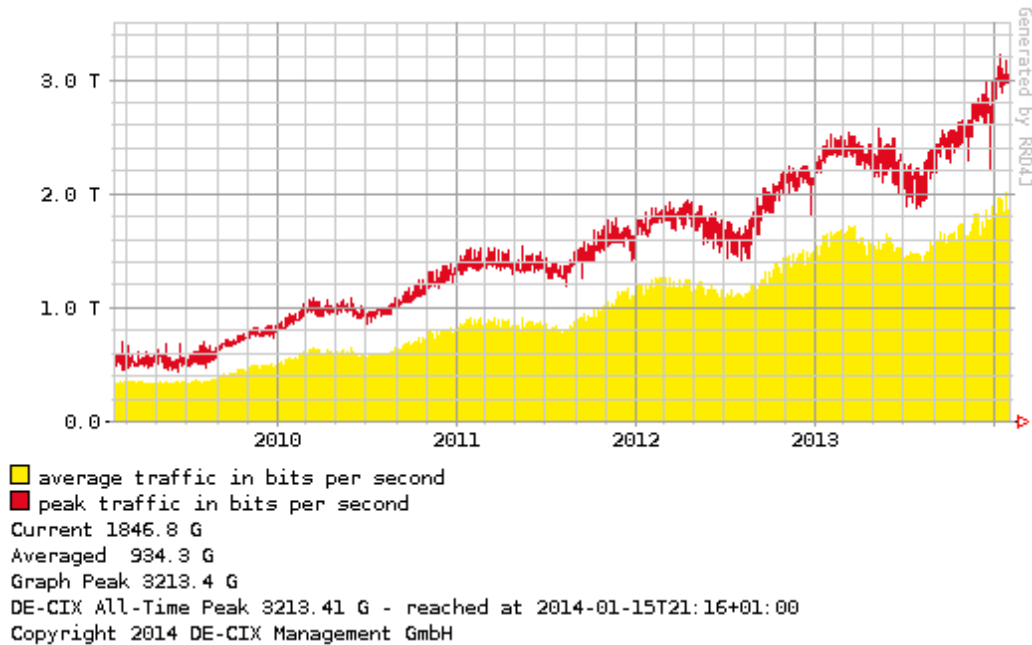
Multi-year graphs give a history of the IXPs performance – a good marketing tool

Meetings and Conferences

- The large IXPs will always make an effort to attend any industry related events where they can get access to potential members i.e.
  - Peering Forums (Africa, Europe, Asia, Global)
  - Regional Technical meetings (AfNOG, AfriNIC, Ripe, NANOG, MENOG, APRICOT, APNIC, LACNIC, etc.)
  - Regional Telecommunications events (Capacity Africa, Connected Africa, etc.)
  - Global Internet events (IGF, WSIS, WICT, WTPF, etc.)
  - Specialised events (Mobile Forums, Gaming Forums, etc.)

- In addition to attending the large IXPs sponsor and support the events they attend for increased visibility

Partners and Collaboration

- The large IXPs have established partnerships with and collaboration with various institutions for strategic reasons including;
  - Carrier neutral data centres who provide them with ideal site/host locations
  - Fibre/Capacity providers who can provide infrastructure for interconnecting the different IXP sites
  - Vendors who provide the peering infrastructure to meet their unusual requirements
  - Resellers and International Carriers who can extend the IXPs network beyond its region through various techniques allowed under the IXP value added services

Communications and Outreach Summary

- The large IXPs have strategically utilised the internal and external resources available to effectively communicate with their audience

- The communications and outreach activities are resource intensive from a financial and human resource point point of view.

- The activities can only be supported by having sustainable IXP business model

- The outcome is a well known IXP that keeps attracting new members every year

Acknowledgement and Attribution

This presentation contains content and information originally developed and maintained by the following organisation(s)/individual(s) and provided for the African Union AXIS Project

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END